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JAPANNING AND ENAMELLING

A HANDBOOK

ON

JAPANNING AND ENAMELLING

FOR CYCLES, BEDSTEADS, TINWARE, ETC.

BY

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"THE ART OF ENAMELLING ON METAL," "A HISTORY OF DECORATIVE ART," "HOUSE DECORATING AND PAINTING," "PRINCIPLES AND PRACTICE OF DIPPING, BURNISHING, LACQUERING, AND BRONZING BRASSWARE," ETC.

FOUR ILLUSTRATIONS.

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PREFACE

In writing the following pages, I have had in view the requirements more particularly of the small tradesmen in our country towns, who, in consequence of the advances made during the past few years in the cycle industry, are often called on to do a job, and that at short notice, when, owing to their lack of apparatus and want of knowledge, they are compelled to send their work to Birmingham or London, at an additional delay and consequent expense. Another reason which impelled me to the writing of this little handbook was the fact that, so far as I have been able to ascertain, no similar work was in existence, and as there must be many tradesmen who would willingly fit up their own japanning plant if they only knew how, I trust to such my pages will commend themselves, as well as to others. With these few words of explanation and introduction, I leave my work in the reader's hands.

W. N. B.

London, *October* 1901.

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JAPANNING AND ENAMELLING

A FEW WORDS ON ENAMELLING

IN enamelling metals the enamel is fused by heat upon the surface of the object, and is incorporated by fusion with its surface. Enamel for metals must therefore be indestructible by heat. A good enamel for coating iron utensils must firmly adhere to the surface, withstand slight shocks, and be capable of resisting changes of temperature and chemical influences. There are two kinds of enamel—the transparent and opaque. The first is the base of all the coloured enamels, which are produced by adding some metallic oxide to this transparent flux. The transparent enamel is produced by fusing the following materials, which are first ground, then dried, fused, and again ground for use:—Three parts siliceous sand, one part chalk, three parts calcined borax or three parts broken crystal glass, a quarter part of nitre, and one part diaphoretic antimony, well washed. Colours are obtained by adding to this transparent enamel the following materials, according to the colour desired:—Blue enamel, by adding oxide of cobalt, or some of its combinations, with the addition of a little nitre; black enamel, by peroxide of manganese or iron and a little cobalt. Clay produces, with about one-third protoxide of iron, a fine black enamel. Of course the worker will do well to have nothing to do with the preparation of any of the above, but they are here included to afford a knowledge only of the necessary constituents.

As is generally known, japanning is the art of covering paper, wood, or metal with a thick coating of hard and brilliant varnish. It originated in Japan—hence its name,—the natives of which used a gum extracted from a certain kind of tree, which on its issuing from the plant is of a creamy tint, but becomes black on exposure to the air. It is, of course, only in its application to metallic surfaces that we are concerned in these pages. Japanning may be said to occupy a position midway between painting and enamelling, and a japanned surface differs from an ordinary painted surface in being harder and more durable, and also in not being easily injured by hot water or in being placed near a fire; while real good japanning is demonstrated by its adhesiveness to the metal to which it has been applied, and its non-liability to chipping—a fault which, as a rule, stamps the common article.

Leaving the theoretical for the practical, it may here be remarked that since the beginning of the nineteenth century many attempts have been made to cover iron with a vitreous surface, and many patents have been taken out for such methods of enamelling, all of which were more or less failures. The chief difficulty in applying enamels to iron arises from the tendency of the metal to oxidise before it reaches the temperature at which the enamel fuses, and to become brittle from the oxide combining with the silica of the enamel. This action being superficial, the mischief is the greater in proportion to the thinness of the iron. Therefore it is much easier to enamel thick cast-iron vessels than thin vessels made of sheet-iron. A gloss may be made by combining either silicic acid or boracic acid with a base; the latter fuses at a lower temperature than the former, but the gloss is much dearer and not so durable as the silica gloss. The enamels used for coating iron consist of a mixture of silica and borax, with various basic substances, such as soda, oxide of tin, alumina, oxide of lead, etc. Lead is not, or ought not to be, used in the enamel for coating culinary vessels.

For the enamelling of cast-iron work, Wagner, in his *Chemical Technology*, gives the following account of another process :—"The surface of the cast-iron to be enamelled is first carefully cleaned by scouring with sand and dilute sulphuric acid; next a somewhat thickish magma, made of pulverised quartz, borax, felspar, kaolin, and water, is brushed over the clean metallic surface as evenly as possible, and immediately after a finely-powdered mixture of felspar, soda, borax, and oxide of tin is dusted over, after which the enamel is burnt in by the heat of a muffle." In France an enamel is applied which consists of 130 parts of flint glass, 20½ parts of carbonate of soda, and 12 parts of boric acid, fused together, and afterwards ground to a fine powder. Experiments have, however, proved that some of the milk-white porcelainous enamel with which cast-iron cooking vessels are now so commonly prepared has a composition such as to render it highly objectionable on account of the facility with which it is acted upon by acid, fruits, common salt, and other ordinary dietetic substances, by which means lead, and even arsenic, is dissolved out in large quantity during the cooking processes.

Another black enamel for iron goods is that of M. Puscher, of Nuremberg, who some few years ago invented the following simple process, by which he claimed to cover iron and any other metals with a black coating similar to enamel, and very much more equal in thickness and regularity of distribution, as it is not laid upon the metal with a brush or any similar tool. The inventor places in a vase 18 inches high sufficient finely powdered coal to cover the bottom of the vessel to a depth of about three-quarters of an inch, and over this, at the height of about one inch, is placed a grating, which carries the objects to be treated. The vessel is then covered and luted down tightly, and placed upon a brisk fire. The vessel is at once filled with steam, which soon evaporates, and is then charged with bituminous vapour. The firing is maintained for about half an

hour, so that the bottom of the vessel is kept at dull red heat, after which it is removed, and, when cool, opened. The remainder of the coal is found in the form of coke, and the objects placed upon the grating, which have been at a fairly high temperature for a considerable time, are found to be covered with a black coating having all the appearances of enamel, but of extreme tenacity and a considerable degree of elasticity. Objects thus treated may be bent and exposed to great variations of temperature without in the least affecting the coating deposited on their surfaces. It is, in fact, a simple process for stove-blacking iron goods, and possesses the advantages and drawbacks of this method of treating metallic surfaces.

Another good black enamel for small articles can be made by mixing a pound of asphaltum with a pound of resin in four pounds of tar oil, well heating the whole in an iron vessel before applying.

A good brown japan can be prepared by separately heating equal quantities of amber and asphaltum, and adding to each one-half the quantity by weight of boiled linseed oil. Both compounds are then mixed together. Copal resin may be substituted for the amber, but it is not so durable.

APPLIANCES AND APPARATUS

Besides the various enamels or japans and varnishes of various colourings and the stove, which will be found described and illustrated, together with the trough, in other pages, the worker will need some iron pots or cauldrons in which to boil the potash "lye" for the cleansing more particularly of old work, some iron ladles both for this work and for pouring the japan on the articles to be covered therewith, a few badger tools and brushes for small fine work, some hooks for the stove, a pair of pliers, a few bits of broom handle cut into short lengths and made taper, so as to fit into the tubes, etc., of bicycles and other

work, so as to keep the hands as free from the japan as possible, some emery powder, pumice-stone powder, tripoli, putty powder, whiting, and a piece of felt or cloth. If he is also doing any common work, a stumpy brush of bristles and a soft leather will also be requisite, together with a file or two. These will about comprise the whole of the articles required, not very expensive, all of which will really not be required by a beginner.

JAPANS OR ENAMELS

The various japans or enamels all have as their groundwork shellac varnish, which is made by dissolving shellac in alcohol, and with which is incorporated the necessary pigment to produce the desired colour; and an improvement to the varnish can be procured by adding two ounces each of shellac and resin to a pint of methylated spirit. Although, as stated elsewhere, I do not advocate the manufacture of these enamels, as they can be purchased cheaper and better, I give a few recipes, as they may be useful to those who like to mix their own materials, or who may not be able to get the enamels. Thus for black, mix lampblack or ivory black—the latter for preference—with the above varnish; while another black can be made by melting one pound of asphaltum and mixing it with a pound of balsam of copaiba, thinning the compound to a workable consistency with hot oil of turpentine; and yet another black can be made by mixing lampblack with oil of turpentine, grinding smooth in a muller, and thinning with copal varnish. Then for white, take flake white or white lead, and grind it up with a sixth of its weight of starch, after which it must be thoroughly dried and mixed with mastic varnish. For yellow, King's yellow is usually used as the pigment, but the tone is very considerably improved by dissolving turmeric in the alcohol before adding the necessary shellac to form the varnish. For red japan, the ground is made up with madder

lake, carmine, or vermilion ground with oil of turpentine, which is employed for the first coating, the second being made of lake and white copal varnish. A green is obtained by using Prussian blue or distilled verdigris with King's yellow. Orange is gained by mixing vermilion or red lead with King's yellow or orange lake; and purple japan can be procured by mixing lake or vermilion with Prussian blue. A good copal varnish for japanners is made thus: Take of pale African copal seven pounds, of pale drying oil half gallon, of oil of turpentine three gallons, which thoroughly fuse and mix in the usual manner. It dries in from twenty to sixty minutes, and may be polished as soon as it is hard, and particularly if stoved. All copal varnishes when properly made are very hard and durable, though less so than those of amber, but they have the advantage over the latter of being paler. They are used for carriages and metal work, and animé is frequently substituted for copal in the copal varnishes of the shops.

TO TEST ENAMEL FOR LEAD

For the simple and rapid detection of the presence of lead in the enamel of culinary vessels, apply a drop of concentrated nitric acid to the enamel of the vessel, after, of course, carefully cleansing it from all impurities, and afterwards thoroughly drying by gentle heating. Then moisten the spot which has been subjected to the action of the acid with a drop of sodium iodide, and the presence of lead will be shown by the formation of yellow iodide of lead. I have thought it well to include this test for lead in those pages, as from experiments made at different times enamelled culinary articles have been found to be so impregnated—a great danger to the consumer.

JAPANNING OR ENAMELLING METALS

In japanning metals, all good work of which should be stoved, they have to be first thoroughly cleaned, and then the

japan ground applied with a badger- or camel-hair brush or other means, very carefully and evenly. Metals usually require from three to five coats, and between each application must be dried in an oven heated from 250 degrees to 300 degrees Fahrenheit,—about 270 degrees being the average. The best grounds for japanning are formed of shellac varnish, the necessary pigments for colouring being added thereto, being mixed with the shellac varnish after they have been ground into a high degree of smoothness and fineness in spirits of turpentine. In japanning it is best to have the oven at rather a lower temperature, increasing the heat after the work has been placed in the oven. When a sufficient number of coats have been laid on—which will usually be two only—the work must be polished by means of a piece of cloth or felt dipped in tripoli or finely powdered pumice-stone. For white grounds fine putty powder or whiting must be employed, a final coat being afterwards given, and the work stoved again. The last coat of all is one of varnish. And here, as a preliminary remark, I would advise that all enamels and japans should be purchased ready-made, as any attempt to make such is almost sure to end in disaster, while, owing to the fact that such are only required for small jobs, it would involve too much trouble and would not pay. It is for this reason that I have only given a few japan recipes, as, although many are available, they do not always turn out as suitable for the purpose as could be desired, in addition to which the ready-made articles can be purchased at a very reasonable price and are much better prepared. I would recommend the operator to procure his enamels a shade or two lighter than he desires to see in the finished article, allowing the chemical action due to the stoving to tone the colours down. Another necessity is to keep the enamel thoroughly well mixed by well stirring it every time it is used, as if this is not done the actual colouring matter is apt to sink to the bottom, the ultimate result being that streaky

work is produced in consequence of this indifferent mixing of the enamelling materials.

It is hardly necessary to state that all japanning or enamelling work must be done in a room or shop absolutely free from dust or dirt, and as far away as possible from any window or other opening leading to the open air, for two reasons—one being that the draught therefrom may cool the oven or stove, and the other that the air may convey particles of dust into the enamelling shop. In fact, it cannot be too much impressed upon the workmen that one of the primary secrets of successful enamelling is absolute cleanliness; consequently all precautions must be taken to ensure that the enamel is perfectly free from grit and dust, and it must be so kept by frequent straining through fine muslin, flannel, or similar material. The work having been thoroughly cleaned and freed from all grease and other foreign matter, it must be suspended or held immediately over the pan elsewhere referred to, and the enamel poured on with an ordinary iron ladle, or covered by means of the brush. When it has been permitted to thoroughly drain, the work should be hung on the hooks on the rods in the oven as seen in the explanatory sketch, care being observed that no portion of the work is in such a position that any superfluous enamel cannot easily drain off,—in other words, the work must lie or hang that it is always, as it were, on the slant. Always bear in mind when shutting the oven door to do so gently, as if a slam is indulged in all the gas jets will be blown out, and an explosion would probably result.

Should the job in hand be a large one, it will be found as well to get a cheaper enamel for the first coat, but if the work is only a small job, it will not be necessary to have more than one enamel, of which a couple of coats at least will be required. When the first coat has thoroughly dried and hardened, the surface will have to be thoroughly rubbed till it is perfectly smooth with tripoli powder and fine pumice-stone, and after-

wards hand polished with rotten-stone and putty powder. And here it may be remarked that the finer the surface is got up with emery powder and other polishing agents the better will be the enamelling and ultimate finish. The rubbing down being finished, another coat of enamel must be applied and the work baked as before, care being always taken to keep the enamel in a sufficiently fluid condition as to enable it to flow and run off the work freely. It can easily be thinned with a little paraffin. A third coat will frequently be advisable, as it improves the finish.

In enamelling cycles, it is well to hang the front forks crown uppermost when they are undergoing the final baking, and it is advisable to bear in mind that wheels require an enamel that will stove at a lower temperature than is called for for other parts of the machine. Some japanners advocate the fluid being put on with camel- or badger-hair brushes, and for the best descriptions of work, final coats, and such like, I agree with them; but this is a detail which can be left to the operator's own fancy, the class of work, etc.; but I would remind him that applying enamel with a brush requires much care and a certain amount of "knack." It is something like successful lacquering in brasswork—it looks very simple, but is not; consequently do not venture on this method of working unless you feel quite confident as to the result. Each succeeding coat of japan gives a more uniform and glossy surface, and for this reason it may, in some cases, be necessary to repeat the operation no fewer than half a dozen times, the final coat being generally a layer of clear varnish only, to add to the lustre.

Care must be taken for light-coloured japans or enamels not to have the temperature sufficiently high to scorch, or the surface will be discoloured, as they require a lower temperature for fixing than the dark japans, which, provided the article is not likely to be injured by the heat, are usually dried at a

somewhat high temperature. The preceding instructions apply only to the best descriptions of work.

When pouring enamel by means of the ladle over pieces of work, do not agitate the liquid too much—at the same time taking care to keep it well mixed—so as to form air bubbles, as this will cause trouble, and in pouring over the work do it with an easy and gentle and not too hurried a motion. In japanning curved pieces, such as mud-guards, etc., in hanging up the work in the oven see that the liquid does not run to the extremities and there form ugly blots or blotches of enamel.

When white or other light tones are used for japanning they are mixed with japanners' varnish, and these require more careful heating in the oven or stove than darker tints or brown or black.

JAPANNING TIN, SUCH AS TEA-TRAYS AND SIMILAR GOODS

For japanning sheet-iron articles, which are really tin goods, such as tea-trays and similar things, first scour them well with a piece of sandstone, which will effectually remove all the scales and make the surface quite smooth. Then give the metal a coating of vegetable black, which must be mixed with black tar varnish, thinned with tar spirits, and well strained. Only a small quantity of this varnish is necessary, as it will dry dead. The article must then be placed in the stove to harden at a temperature of 212 degrees Fahrenheit, there to remain for from ten to twelve hours. When taken out of the stove, the articles must be allowed to get cold, after which they must be given a coat of black tar varnish, which, if necessary, must be thinned with tar spirits, a stiff, short bristle brush being employed, and the varnish put on sparingly, so that it will not "run" when it gets warm. Two coats of this varnish on top of the vegetable black coating are usually sufficient, when done

properly, but a third coating much improves the work, and from ten to twelve hours' hardening will be necessary between each coating. The small lumps which will be more or less certain to arise will require to be rubbed down between each application by a small and smooth piece of pumice-stone.

If it is desired to add gold or bronze bands or any kind of floral or other kind of fancy decorations, these are painted on, after the ground japanning has been done, in japanners' gold size, and then the gold leaf is applied, or the bronze or other metal powder is dusted on, after which the objects so treated are again placed in the stove, where they will not require to be kept near so long as for the ordinary japanning. After they have been removed, the gilt or bronzed portions must be treated with a protecting coat of white spirit varnish. Transfers can be applied in the same way.

Tinned iron goods are the most largely japanned, and for these brown and black colours are principally employed. Both are obtained by the use of brown japan, the metal having a preliminary coating of black paint when black is required. Only one coating of brown japan is given to cheap goods, but for better articles two or more are applied. For these a possible final dressing with pumice-stone and then with rotten-stone, to be finally rubbed with a piece of felt or cloth, or even the palm of the hand, may be necessary, but as a rule not.

Large numbers of articles of the above description, such as tea-trays, tea-canisters, cash-boxes, coal-boxes, and similar goods, are japanned at Birmingham, and it is to such that the preceding instructions apply.

ENAMELLING OLD WORK

In all cases of re-enamelling old work, it is absolutely necessary to remove all traces of the first enamelling, and if

this has been well done in the first instance, it will prove no mean job. The best way to clean the work is to soak it in a strong "lye" of hot potash, when the softened enamel can be wiped or brushed off,—this latter method being pursued in the more intricate and ungetatable portions of the work. New work, which has not been enamelled, can be treated in the same way for the removal of all grease, stains, finger-marks, etc., and too much attention cannot be paid to the initial preparation of the surface of the metal, to have it thoroughly even and smooth, as it adds so much to the ultimate finish and appearance of the work. Plenty of labour must be bestowed before the final coat, as any blemish will show through this finishing, and so mar what would otherwise be a highly satisfactory bit of work. In all kinds of bicycle work, whether new or old, the most satisfactory results are obtained by the application of at least two, and sometimes four or five, successive coats of good but thin enamel, as this will impart the necessary perfect coat, combined with durability, a high finish, and a good colour. A good enamel should be sufficiently hard, so as not to be scratched on the merest touch or rubbing. It will, of course, be understood that no solder-work must be put into the stove, or the pieces will separate. Should any of this work be discovered, the pieces must be taken apart, and then brazed together before being enamelled, and put in the stove.

ENAMEL FOR CAST-IRON

A very white and firmly adhering enamel for cast-iron articles can be made thus: Keep the articles at a red heat in sand for half an hour, then allow to cool off slowly, and cleanse with hot diluted sulphuric or hydrochloric acid, then rinse in water and dry. Next apply a ground mass composed of flint-glass, 4 parts; borax, 3 parts; minium, 1 part; oxide

of zinc, 1 part,—all finely powdered and roasted at a red heat for four hours, then rendered semi-fluid by increased temperature, then cooled in cold water and one part of it mixed with 2 parts of bone meal and made into a paste with water. When the coating in the article is dry, apply a surface coat composed of a mixture of 32 parts of calcined bones, 16 parts of china clay, 14 parts of felspar, 4 parts of potash, mixed with water, dried, cooled, and, when powdered, made into a paste with 16 parts of flint glass, $5\frac{1}{2}$ parts of calcined bones, and 3 parts of calcined quartz mixed with sufficient water. When this second coat is dry, apply a mixture composed of 4 parts of felspar, 4 parts of pure sand, 4 parts of potash, 6 parts of borax, 1 part of oxide of zinc, 1 part of saltpetre, 1 part of white arsenic, and 1 part of pure chalk, mixed, calcined, and cooled and rubbed to a fine powder with $3\frac{1}{2}$ parts of calcined bones and 3 parts of quartz. The coated articles are heated in a furnace, which fuses the last two coatings and forms an adhesive and brilliant white enamel. This is no doubt a very good formula, but unless the tradesman is in a very extensive way of business, I would not advise his going to the trouble to make it, but to purchase instead a good and reliable enamel.

GLASS ENAMEL FOR IRON

Kitchen utensils, etc., coated with this enamel are not affected by the atmosphere, fire, or rust. To make, mix intimately 4 parts of powdered glass, 2 parts of spar, 1 part of saltpetre, and $\frac{1}{4}$ of a part of zinc oxide. Fuse in a crucible, and pour into moulds to cool. For use, the necessary quantity is triturated with water. Heat the iron utensil to a red heat in a furnace, and apply the enamel, which will present a brilliant glassy appearance. To colour the enamel blue, add cobaltic oxide; for red, ammonium; for black, manganic

oxide; for yellow, uranic oxide; for brown, ferric oxide; for green, a mixture of 2 parts of stannic oxide and 1 part of manganic oxide; and for pure white, stannic oxide.

ENAMEL FOR COPPER COOKING UTENSILS

Powder and mix 12 parts of white fluorspar, 12 parts of unburned gypsum, and 1 part of borax, and fuse the mixture in a crucible. Pour the mass out, and when cold triturate it into a paste with water. Apply this with a brush to the inside of the vessel, and place the latter in a moderately warm place, so that the paste will dry uniformly. When dry, heat the vessel to such a degree in a stove that the paste which has been applied liquifies, and when cold the result will be a white opaque enamel. I do not advocate the manufacture of this by the workman, as the requisite enamel can be purchased. In another page I give a test for detecting lead in enamelled culinary articles.

In case any of the readers of this little volume should be called on to work in new copper goods, they will probably be glad to learn that a couple of coats of boiled linseed oil makes the best varnish for such work. The first coat must be thoroughly dry before the second coat is put on.

THE ENAMELLING STOVE

Owing largely to the strides made in the cycle trade, all enamelling is stoved by means of gas, and of this a plentiful supply is necessary. Enamelling stoves may really be described as hot-air cupboards or ovens, and for a stove which will answer most requirements—say one of 6 feet by 6 feet by 3½ feet—six rows of atmospheric burners will be necessary to heat it, while it will be also advisable to fix pipes of

$1\frac{1}{4}$ inch internal diameter from the gas meter to the stove. The atmospheric burners can be made from the requisite number of pieces of $1\frac{1}{4}$-inch gas tube $3\frac{1}{2}$ feet in length, one end of each being stopped, and having $\frac{1}{8}$-inch holes drilled therein at intervals of about 1 inch, the other end being left open for the insertion of ordinary $\frac{3}{8}$-inch brass gas taps. Another plan preferred by some japanners is to have three rows of burners the full length of the stove, which, under some circumstances, due to structural conditions, will be found more suitable. Anyway, whatever the position of the stove, allowance must be made for a temperature up to 400 degrees Fahrenheit to be raised. In old-fashioned ovens the heat is applied by means of external flues, in which hot air or steam is circulated, but this system is generally unsatisfactory, the supply of heat having to be controlled by dampers or stop-cocks, and this has given place to the gas apparatus. Another simple form of oven, though not one which I shall recommend, is a species of sheet-iron box, which is encased by another and larger box of the same shape, so placed that from two to three inches of interspace exists between the two boxes. To this interspace heat is applied, and a flue will have to be affixed to this apparatus to carry off the vapours which arise from the enamel or japan. For a permanent oven the example illustrated at Figs. 1 and 2 is about as good as any, though to guard against fire it would be as well to have a course of brick-work beneath the oven, while if this is not possible on account of want of height, a sheet or so of zinc or iron will help to mitigate the danger. It is also advisable, if the apartment is a low-pitched one, to have a sheet of iron or zinc suspended by four corner chains from the ceiling in order to protect this from firing through the heat from the enamelling oven. Of course, it will be understood that every portion of the stove must be put together with rivets, no soldered work being permissible.

To those who wish to construct their own stove, it will be found that the framework can be shaped out of one-inch angle iron, the panels or walls being constructed of sheet-iron of about 18 gauge, the whole being riveted together. The front will be occupied in its entire space by a door, which will require to be hung on strong iron hinges, and the framework of this door should be constructed of 1 inch by $\frac{1}{4}$ inch iron—

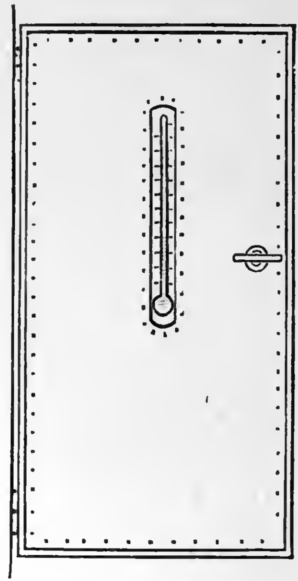

FIG. 1.—Door of Oven when shut.

a little stouter material will really be no disadvantage—to which the sheet-iron plates must be riveted. In the centre of the door must be cut a slit, say $1\frac{1}{2}$ inch by 9 inches, which will require to be covered with mica or talc, behind which must be placed the thermometer, so as it can be seen during the process of stoving, without the necessity of opening the

door, which, of course, more or less cools the oven. And, by the way, this thermometer must register higher than the highest temperature the oven is capable of reaching. Appended are two sketches of the stove, interior and exterior, which will give an idea of what a japanner's stove is like.

Inside the stove it will be necessary to fix rows of iron rods, some four inches from the top, from which to suspend the work,

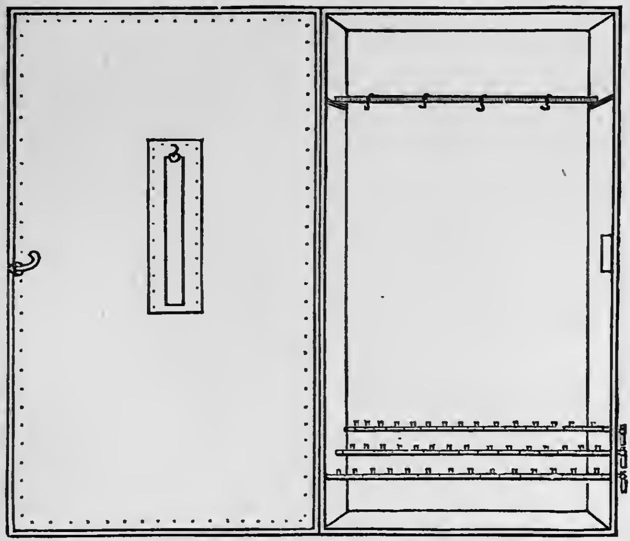

FIG. 2.—Showing Stove when open, and Back of Door.

or angle-iron ledges can be used on which the rods or bars can be fixed, these arrangements being varied according to the particular description of work, individual fancy, or other circumstances. Large S hooks are about the handiest to use. A necessary adjunct of the stove is a pan, which can be made by any handy man or tinworker, which should be made to fit the bottom of the stove, above the gas jets, it being arranged

that it rests on two side ledges, or along some rods. One a couple of inches in depth will be found sufficient, and it will repay its cost in the saving of enamel, it being possible with its use to enamel a bicycle with as little as a gallon of enamel. Some workmen have the tray made with a couple of hinged side flaps, to turn over and cover up the pan when not in use, but this is a matter of fancy. Of course, they must always be covered up when not in use. For those who would prefer to use Bunsen burners I show at Fig. 3 a sketch of the best kind to employ, these having three rows of holes in each.

When brick ovens are employed they must be lined with sheet-iron, and in these very rare circumstances where gas is not available, the stove can be heated with coal or wood, which

FIG. 3.—Bunsen Burner.

will, of course, involve a total alteration in the structural arrangements. I have not given the details here, as I do not think the necessity will ever arise for their use, and for the same reason I have refrained from giving the particulars for heating by steam and electricity, or the other methods which have been adopted by various workers, as there is no question but that a gas stove or oven, as described, is about the best and handiest for most descriptions of japanning work.

ENAMELLING BEDSTEAD FRAMES AND SIMILAR LARGE PIECES

At Fig. 4 is shown a trough in which large pieces, such as bedsteads, bicycle frames, etc., are dipped or immersed. For

the first mentioned class of work such high finish is not required as for bicycles, and consequently the enamel need not be applied with a brush, nor will it be necessary to rub down the work between each coat, but instead the pieces can be literally dipped in the tank of liquid, then allowed to drain on to the dripping-board,—the superfluous enamel thus finding its way back into the trough or tank, the dripped articles being afterwards placed in the oven to harden. The trough must be of sufficient dimensions to allow the pieces of work to be com-

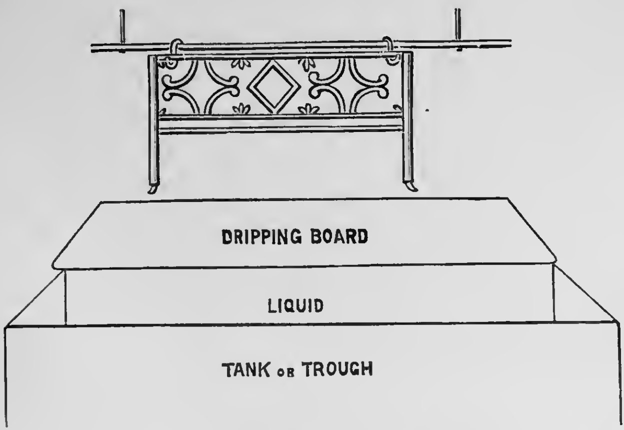

FIG. 4.—Trough for Dipping Bedstead Frames and other Large Work.

pletely immersed, and the dripping-board should be set at an angle of about forty-five degrees.

Bedstead frames will never require more than two coats, and the commoner class of goods only one. I would not advise the tradesman in a small way of business to go to the expense of a trough, etc., as it calls for much more room than is ordinarily available, but if he has the necessary plant for bicycle work he can, of course, do an occasional job of the other kind.

Common tin and ironware articles, such as cups, mugs, plates, etc., are usually only treated once, those articles which are to be enamelled outside and inside the same being dipped and then baked, the process being slightly varied for those which are white inside and another colour outside. For this description of work, blue, black, and brown are the most common colours employed, and a large quantity of this class of goods is turned out at Birmingham. As the enamelling of these articles hardly falls within the purview of this little work it will not be necessary to deal with them in any fuller detail.

PAINTS AND VARNISHES FOR METALLIC SURFACES

Ordinary oil paints consist of linseed oil, sometimes more or less adulterated, mixed by grinding with a pigment, which latter is usually a mineral substance reduced to a fine powder. The object of using a pigment, aside from its colour, is three-fold—(1) it hardens the film, which will thus better resist abrasion; (2) it makes it possible to apply a thicker film, which also wears longer; and (3) the particles of pigment tend to fill up the pores, which are naturally present in the oil film, and thus the porosity is reduced.

The pigments used for preservative paints are few in number as compared with those used in house and other decorative painting. They may be described briefly as follows:—White lead: this is a mixture of lead hydrate and carbonate, and this is sometimes sold as a dry pigment, but more frequently as paste white lead, which is nine parts dry pigment ground with one part by weight of raw linseed oil. This may be made into a paint by thinning it with oil, and usually a little turpentine is also added. The object of the latter is not to cheapen it,—indeed, at the present time turpentine is worth more than oil,—

but to make the work move freely under the brush and to increase the proportion of pigment in the film. This is a matter which it is very easy to overdo, and if too much turpentine is added, there will not be enough oil to act as cementing material for the pigment, which will then be easily removed.

White zinc is an oxide of zinc, white in colour, and it requires more oil than white lead. It is less opaque; its opacity or covering capacity is usually estimated at three-fifths that of white lead. Paint made with it does not readily brush off as a powder, but sometimes seems to come off in flakes. Painters say it peels or scales. It is commonly used mixed with white lead, and the mixture seems to be better than either substance alone. Paints made with these pigments are frequently, perhaps it may be said commonly, adulterated with other white powdered substances, such as kaolin and barytes, which are not particularly harmful, and whiting or carbonate of lime, which is actively injurious. While dry these substances appear white, but when mixed with oil they seem to be transparent. They are without value as pigments, and must be regarded as adulterants. White lead and white zinc are practically the only white pigments, and must form the basis of all light-coloured paints. Other light colours are made by adding some tinting material to them. The principal yellow colour is chromate of lead, or chrome yellow. This is a very brilliant colour, rather deep in shade, and the pale shades are made by adding white lead. Chrome green is a mixture of chrome yellow and Prussian blue, and is the only green pigment in common use. Prussian blue is a ferrocyanide of iron, dark blue in colour. The common light blue pigment is ultramarine blue, an artificial product of complex constitution, the exact composition and preparation of which are secret. The yellows, greens, and blues are not much used in paints for structural work, but this is not the case with red pigments, the most important of which are the oxides of iron. For this purpose

the sesquioxide, which is known in mineralogy as hematite, and the hydrated sesquioxide, or limonate, are used. Usually the two are mixed together in various proportions, the pigment being produced by grinding a natural oxide rock, which commonly contains from ten to sixty per cent. of other mineral matter, commonly silicates. The colour of these oxides varies from bright red to dark brown, the bright shades commonly containing most hydratic oxide, and the brown (rarely dark purple) shades being chiefly anhydrous; oxides of a bright purple or maroon tint are, however, hydrated. It is commonly believed that the brown or the dark red shades—that is, the anhydrous oxides—are more durable than the others. Some of these oxides are of artificial origin, such as Venetian red, which is a by-product originally containing some sulphuric acid, to neutralise which it has been saturated with lime; and in consequence the finished pigment contains a large percentage of sulphate of lime, which cannot be regarded as a desirable ingredient. A knowledge of the chemical constituents of an oxide pigment is therefore desirable. A considerable portion of silica, or of highly acid silicates, is probably not objectionable, especially if the product is nearly anhydrous; but if there is ground for believing that the silicates themselves are hydrated, they are simply clay, which is objectionable; and if any lime salts, soluble in water or acid, are present, the material is not suited for the purpose.

Oxide pigments are particularly open to the criticism of being, in many cases, not finely ground—a most serious objection. Any good paint should be so fine that it feels smooth and even when rubbed on glass or porcelain with a palette knife. The importance of fine grinding is not likely to be overestimated. Ochres, umber, and sienna are also classed with the iron oxide pigments, and usually contain a little manganese, which increases the drying qualities of the oil. They also contain various earthy colouring matters. The

ochres are yellow in colour, and the iron oxide in them is hydrated. They are often used in conjunction with white lead or zinc.

Carbon, in one form or another, is the base of all black pigments. By far the most common of these, as used in structural plants, is graphite. Other black pigments are lamp-black (including carbon black) and boneblack, the former being produced in many grades, varying in price from two-pence to half a crown per pound. Boneblack, which is refuse from the sugar-house black, varies in the percentage of carbon contained, which is usually about ten or twelve per cent., the remainder being the mineral matter originally present in the bone, and containing three or four per cent. of carbonate, whilst most of the remainder is phosphate of lime. Lampblack is an absolutely impalpable powder, which has a small amount of oily matter in it, and greatly retards the drying of the oil with which it may be mixed. For this reason it is not used by itself, but is added in small quantity to other paints, which it affects by changing their colour, and probably their durability. For example, it is a common practice to add it to red lead, in order to tone down its brilliant colour, and also to correct the tendency it has to turn white, due to the conversion of the red oxide of lead into the carbonate.

BLACKING FOR IRON

For colouring iron and steel a dead black of superior appearance and permanency, the following is a good formula :—1 part bismuth chloride, 2 parts mercury bi-chloride, 1 part copper chloride, 6 parts hydrochloric acid, 5 parts alcohol, and 50 parts lamp black, these being all well mixed. To use this preparation successfully—the article to be blacked or bronzed

being first made clean and free from grease—it is applied with a swab or brush, or, better still, the object may be dipped into it; the liquid is allowed to dry on the metal, and the latter is then placed in boiling water, the temperature being maintained for half an hour. If, after this, the colour is not so dark as is desired, the operation has simply to be repeated, and the result will be found satisfactory. After obtaining the desired degree of colour, the latter is fixed, as well as much improved generally, by placing for a few minutes in a bath of boiling oil, or by coating the surface with oil, and heating the object till the oil is completely driven off. The intense black obtained by this method is admirable.

Another black coating for ironwork, which is really a lacquer, is obtained by melting ozokerite, which becomes a brown resinous mass, with a melting-point at 140 degrees Fahrenheit. The melted mass is then further heated to 212 degrees Fahrenheit, the boiling-point of water. The objects to be lacquered are scoured clean by rubbing with dry sand, and are dipped in the melted mass. They are then allowed to drip, and the ozokerite is ignited by the objects being held over a fire. After the ozokerite has burned away, the flame is extinguished, and the iron acquires a firmly adhering black coating, which resists atmospheric influences, as well as acids and alkalies. If the black iron vessels are to contain alkaline liquids, the above operation is repeated.

A good cheap stock black paint or varnish for ironwork is prepared as follows:—Clear (solid) wood tar, 10 lb.; lamp-black or mineral black, $1\frac{1}{4}$ lb.; oil of turpentine, $5\frac{1}{2}$ quarts. The tar is first heated in a large iron pot to boiling-point, or nearly so, and the heat is continued for about four hours. The pot is then removed from the fire out of doors, and while still warm, and not hot, the turpentine, mixed with the black, is stirred in. If the varnish is too thick to dry quickly, add more turpentine. Benzine can be used instead of turpentine,

but the results are not so good. Asphaltum is preferable to the cheap tar.

To make another good black varnish for ironwork, take 8 lb. of asphaltum and fuse it in an iron kettle, then add 2 gallons of boiled linseed oil, 1 lb. of litharge, ½ lb. of sulphate of zinc (add these slowly, or the mixture will boil over), and boil them for about three hours. Then add 1½ lb. of dark gum amber, and boil for two hours longer, or until the mass will become quite thick when cool. After this it should be thinned with turpentine to the proper consistency.

VARNISHES FOR IRONWORK

A reliable authority gives the following as a very good recipe for ironwork varnish. Take 2 lb. of tar oil, ½ lb. of pounded resin, and ½ lb. of asphaltum, and dissolve together, and then mix while hot in an iron kettle, taking all care to prevent the flames getting into contact with the mixture. When cold the varnish is ready for application to outdoor ironwork. Another recipe is to take 3 lb. of powdered resin, place it in a tin or iron vessel, and add thereto 2½ pints of spirits of turpentine, which well shake, and then let it stand for a day or two, giving it an occasional shake. Then add to it 5 quarts of boiled oil, shake it thoroughly well all together, afterwards letting it stand in a warm room till it gets clear. The clear portion can then be drawn off and used, or reduced with spirits of turpentine till of the requisite consistency. For making a varnish suitable for iron patterns, take sufficient oil of turpentine for the purpose of the job in hand, and drop into it, drop by drop, some strong commercial oil of vitriol, when the acid will cause a dark syrupy precipitate in the oil of turpentine, and continue to add the drops of vitriol till the precipitate ceases to act, after which pour off the liquid and wash the

syrupy mass with water, when it will be ready for use. When the iron pattern is to be varnished, it must be heated to a gentle degree, the syrupy product applied, and then the article allowed to dry.

A fine black varnish suitable for the covering of broken places in sewing machines and similar articles, where the japanned surface has become injured or scratched, can be made by taking some fine lampblack or ivory-black, and thoroughly mixing it with copal varnish. The black must be in a very fine powder, and to mix the more readily it should be made into a pasty mass with turpentine. For the ordinary repairing shop this will be found very handy.

The following is a simple way for tarring sheet-iron pipes to prevent rusting. The sections as made should be coated with coal tar, and then filled with light wood shavings, and the latter set alight. The effect of this treatment will be to render the iron practically proof against rust for an indefinite period, rendering future painting unnecessary. It is important, of course, that the iron should not be made too hot, or kept hot for too long a time, lest the tar should be burnt off.

Another varnish for coating iron is compounded of 120 parts mercury, 10 parts tin, 20 parts green vitriol, 120 parts water, and 15 parts hydrochloric acid of 1·2 specific gravity.

The following is a varnish for iron and steel given by a recognised authority :—Five parts of camphor and elemi, 15 parts of sandarach, and 10 parts of clear grains of mastic, are dissolved in the requisite quantity of alcohol, and applied cold.

PROCESSES FOR TIN PLATING

In those days of making everything look what it is not, perhaps the best and cheapest substitute for silver as a white

coating for table ware, culinary vessels, and the many articles requiring such a coating, is pure tin. It does not compare favourably with silver in point of hardness or wearing qualities, but it costs very much less than silver, is readily applied, and can be easily kept clean and bright. In tinning hollow ware on the inside the metal article is first thoroughly cleansed by pickling it in dilute muriatic or sulphuric acid and then scouring it with fine sand. It is then heated over a fire to about the melting-point of tin, sprinkled with powdered resin, and partly filled with melted pure grain tin covered with resin to prevent its oxidisation. The vessel is then quickly turned and rolled about in every direction, so as to bring every part of the surface to be covered in contact with the molten metal. The greater part of the tin is then thrown out and the surface rubbed over with a brush of tow to equalise the coating; and if not satisfactory the operation must be repeated. The vessels usually tinned in this manner are of copper and brass, but with a little care in cleaning and manipulating, iron can also be satisfactorily tinned by this means. The vessels to be tinned must always be sufficiently hot to keep the metal contained in them thoroughly fused. This is covering by contact with melted tin.

The amalgam process is not so much used as it was formerly. It consists in applying to the clean and dry metallic surface a film of a pasty amalgam of tin with mercury, and then exposing the surface to heat, which volatilises the latter, leaving the tin adhering to the metal.

The immersion process is the best adapted to coating articles of brass or copper. When immersed in a hot solution of tin properly prepared the metal is precipitated upon their surfaces. One of the best solutions for this purpose is the following:—

Ammonia alum	$17\frac{1}{4}$ ounces.
Boiling water	$12\frac{1}{2}$ pounds.
Protochloride of tin . . .	1 ounce.

The articles to be tinned must be first thoroughly cleansed, and then kept in the hot solution until properly whitened. A better result will be obtained by using the following bath, and placing the pieces in contact with a strip of clean zinc, also immersed:—

Bitartrate of potassia	14 ounces.
Soft water	24 ,,
Protochloride of tin	1 ounce.

It should be boiled for a few minutes before using.

The following is one of the best solutions for plating with tin by the battery process:—

Potassium pyrophosphate . . .	12 ounces.
Protochloride of tin	$4\frac{1}{2}$,,
Water	20 ,,

The anode or feeding-plate used in this bath consists of pure Banca tin. This plate is joined to the positive (copper or carbon) pole of the battery, while the work is suspended from a wire connected with the negative (zinc) pole. A moderately strong battery is required, and the work is finished by scratch-brushing.

In Weigler's process a bath is prepared by passing washed chlorine gas into a concentrated aqueous solution of stannous chloride to saturation, and expelling excess of gas by warming the solution, which is then diluted with about ten volumes of water, and filtered, if necessary. The articles to be plated are pickled in dilute sulphuric acid, and polished with fine sand and a scratch brush, rinsed in water, loosely wound round with zinc wire or tape, and immersed in the bath for ten or fifteen minutes at ordinary temperatures. The coating is finished with the scratch-brush and whiting. By this process cast- or wrought-iron, steel, copper, brass, and lead can be tinned without a separate battery. The only disadvantage of the process is that the bath soon becomes clogged up with zinc chloride, and the tin salt must be frequently removed. In Hern's process a bath composed of—

Tartaric acid	2 ounces
Water	100 ,,
Soda	3 ,,
Protochloride of tin	3 ,,

is employed instead of the preceding. It requires a somewhat longer exposure to properly tin articles in this than in Weigler's bath. Either of these baths may be used with a separate battery.

GALVANISING

Galvanising, as a protecting surface for large articles, such as enter into the construction of bridges, roofs, and shipwork, has not quite reached the point of appreciation that possibly the near future may award to it. Certain fallacies existed for a long time as to the relative merits of the dry or molten and the wet or electrolytical methods of galvanising. The latter was found to be too costly and slow, and the results obtained were erratic and not satisfactory, and soon gave place to the dry or molten bath process, as in practice at the present day; but the difficulty of management in connection with large baths of molten material, the deterioration of the bath, and other mechanical causes, limit the process to articles of comparatively small size and weight. The electro deposition of zinc has been subject to many patents, and the effects to introduce it have been lamentable in both a mechanical and financial sense. Most authorities recommend a current density of 18 or 20 ampères per square foot of cathode surface, and aqueous solutions of zinc sulphate, acetate or chloride, ammonia, chloride or tartrate, as being the most suitable foı deposition. Electrolytes made by adding caustic potash or soda to a suitable zinc salt have been found to be unworkable in practice on account of the formation of an insoluble zinc oxide

on the surface of the anode and the resultant increased electrical resistance; the electrolytes are also constantly getting out of order, as more metal is taken out of the solution than could possibly be dissolved from the anodes by the chemicals set free on account of this insoluble scale or furring up of the anodes, which sometimes reaches one-eighth of an inch in thickness. To all intents and purposes the deposits obtained from acid solutions under favourable circumstances are fairly adhesive when great care has been exercised to thoroughly scale and clean the surface to be coated, which is found to be the principal difficulty in the application of any electro-chemical process for copper, lead, or tin, as well as for zinc, and that renders even the application of paint or other brush compounds so futile unless honestly complied with. Unfortunately these acid zinc coatings are of a transitory nature, their durability being incomparable with hot galvanising, as the deposit is porous and retains some of the acid salts, which cause a wasting of the zinc, and consequently the rusting of the iron or steel. Castings coated with acid zinc rust comparatively quickly, even when the porosity has been reduced by oxidation, aggravated no doubt by some of the corroding agents—sal-ammoniac, for instance—being forced into the pores of the metal. Other matters of serious moment in the electro-zincing process, apart from the slowness of the operation, were the uncertain nature, thickness, and extent of the coating on articles of irregular shape, and the formation of loose, dark-coloured patches on the work; the unhealthy non-metallic look and want of brilliancy and lustre prevented engineers and the trade from accepting the process or its results, except for the commoner articles of use. To obviate any tendency of the paint to peel off from the zinc surface, as it generally manifests a disposition to do, it is recommended to coat all the zinc surfaces, previous to painting them, with the following compound:—1 part chloride of copper, 1 part nitrate of copper, 1 part sal-ammoniac, dissolved in 61 parts water, and then add

1 part commercial hydrochloric acid. When the zinc is brushed over with this mixture it oxidises the surface, turns black, and dries in from twelve to twenty-four hours, and may then be painted over without any danger of peeling. Another and more quickly applied coating consists of bi-chloride of platinum, 1 part dissolved in 10 parts distilled water, and applied either by a brush or sponge. It oxidises at once, turns black, and resists the weak acids, rain, and the elements generally.

Zinc surfaces, after a brief exposure to the air, become coated with a thin film of oxide—insoluble in water,—which adheres tenaciously, forming a protective coating to the underlying zinc. So long as the zinc surface remains intact, the underlying metal is protected from corrosive action, but a mechanical or other injury to the zinc coating that exposes the metal beneath, in the presence of moisture causes a very rapid corrosion to be started, the galvanic action being changed from the zinc positive to zinc negative, and the iron, as the positive element in the circuit, is corroded instead of the zinc. When galvanised iron is immersed in a corrosive liquid, the zinc is attacked in preference to the iron, provided both the exposed parts of the iron and the protected parts are immersed in the liquid. The zinc has not the same protective quality when the liquid is sprinkled over the surface and remains in isolated drops. Sea air, being charged with saline matters, is very destructive to galvanised surfaces, forming a soluble chloride by its action. As zinc is one of the metals most readily attacked by acids, ordinary galvanised iron is not suitable for positions where it is to be much exposed to an atmosphere charged with acids sent into the air by some manufactories, or to the sulphuric acid fumes found in the products of combustion of rolling mills, iron, glass, and gas works, etc., and yet we see engineers of note covering-in important buildings with corrugated and other sheets of iron, and using galvanised iron tie rods, angles, and other constructive shapes in blind confidence of the protective

power of the zinc coating; also in supreme indifference as to the future consequences and catastrophes that arise from their unexpected failure. The comparative inertia of lead to the chemical action of many acids has led to the contention that it should form as good, if not a better, protection to iron than zinc, but in practice it is found to be deficient as a protective coating against corrosion. A piece of lead-coated iron placed in water will show decided evidences of corrosion in twenty-four hours. This is to be attributed to the porous nature of the coating, whether it is applied by the hot or wet (acid) process. The lead does not bond to the plate as well as either of the other metals—zinc, tin, copper, or any alloys of them. The following table gives the increase in weight of different articles due to hot galvanising:—

Description of Article.	Weight of Zinc per Square Foot.	Percentage of Increase of Weight.
Thin sheet-iron .	1·196 ounces	18·2
$\frac{5}{16}$-in. plates . .	1·76 ,,	2·0
4-in. cut nails . .	2·19 ,,	6·72
$\frac{7}{8}$-in. die bolt and nut	approximately 1·206 ounces	1·00

Tin is often added to the hot bath for the purpose of obtaining a smoother surface and larger facets, but it is found to shorten the life of the protective coating very considerably.

A portion of a zinc coating applied by the hot process was found to be very brittle, breaking when attempts were made to bend it; the average thickness of the coating was ·015 inch. An analysis gave the following result:—tin, 2·20; iron, 3·78; arsenic, a trace; zinc (by difference), 94·02. A

small quantity of iron is dissolved from all the articles placed in the molten zinc bath, and a dross is formed amounting in many cases to 25 per cent. of the whole amount of zinc used. The zinc-iron alloy is very brittle, and contains by analysis 6 per cent. of iron, and is used to cast small art ornaments from. A hot galvanising plant, having a bath capacity of 10 feet by 4 feet by 4½ feet outside dimensions, and about 1 inch in thickness, will hold 28 tons of zinc. With equal amounts of zinc per unit of area, the zinc coating put on by the cold process is more resistant to the corroding action of a saturated solution of copper sulphate than is the case with steel coated by the ordinary hot galvanising process; or, to put it in another form, articles coated by the cold process should have an equally long life under the same conditions of exposure that hot galvanised articles are exposed to, and with less zinc than would be necessary in the ordinary hot process. The hardness of a zinc surface is a matter of some importance. With this object in view aluminium has been added from a separate crucible to the molten zinc at the moment of dipping the article to be zinced, so as to form a compound surface of zinco-aluminium, and to reduce the ashes formed from the protective coverings of sal-ammoniac, fat, glycerine, etc. The addition of the aluminium also reduces the thickness of the coating applied. Cold and hot galvanised plates appear to stand abrasion equally well. Both pickling and hot galvanising reduce the strength, distort, and render brittle iron and steel wires of small sections.

METAL POLISHES

The active constituent of all metal polishes is generally chalk, rouge, or tripoli, because these produce a polish on metallic surfaces. The following recipes give good polishing soaps:—

(1) 20 to 25 lb. liquid and soap is intimately mixed with about 30 lb. of Swedish chalk and ½ lb. Pompeiian red. (2) 25 lb. liquid cocoanut oil soap is mixed with 2 lb. tripoli and 1 lb. each alum, tartaric acid, and white lead. (3) 25 lb. liquid cocoanut oil soap is mixed with 5 lb. rouge and 1 lb. ammonium carbonate. (4) 24 lb. cocoanut oil are saponified with 12 lb. soda lye of 38 to 40 degrees B., after which 3 lb. rouge, 3 lb. water, and 32 grms. ammonia are mixed in. Good recipes for polishing pomades are as follows:—(1) 5 lb. lard and yellow vaseline is melted and mixed with 1 lb. fine rouge. (2) 2 lb. palm oil and 2 lb. vaseline are melted together, and then 1 lb. rouge, 400 grs. tripoli, and 20 grs. oxalic acid are stirred in. (3) 4 lb. fatty petroleum and 1 lb. lard are heated and mixed with 1 lb. of rouge. The polishing pomades are generally perfumed with essence of myrbane. Polishing powders are prepared as follows:—(1) 4 lb. magnesium carbonate, 4 lb. chalk, and 7 lb. rouge are intimately mixed. (2) 4 lb. magnesium carbonate are mixed with 150 grs. fine rouge. An excellent and harmless polishing water is prepared by shaking together 250 grs. floated chalk, 1 lb. alcohol, and 20 grs. ammonia. Gilded articles are most readily cleansed with a solution of 5 grs. borax in 100 parts water, by means of a sponge or soft brush. The articles are then washed in pure water, and dried with a soft linen rag. Silverware is cleansed by rubbing with a solution of sodium hyposulphite.

COLOURS FOR POLISHED BRASS

The following are the formulæ for a variety of baths, designed to impart to polished brass various colours. The brass objects are put into boiling solutions composed of different salts, and the intensity of the shade obtained is dependent upon the duration of the immersion. With a solution com-

posed of sulphate of copper 120 grs., hydrochlorate of ammonia 30 grs., and water 1 quart, greenish shades are obtained. With the following solution, all the shades of brown, from orange-brown to cinnamon, are obtained :—Chlorate of potash 150 grs., sulphate of copper 150 grs., and water 1 quart. The following solution gives the brass first a rosy tint, and then colours it violet and blue :—Sulphate of copper 435 grs., hyposulphite of soda 300 grs., cream of tartar 150 grs., and water 1 pint. Upon adding to this solution ammoniacal sulphate of iron 300 grs., and hyposulphite of soda 300 grs., there are obtained, according to the duration of the immersion, yellowish, orange, rosy, and then bluish shades. Upon polarising the ebullition, the blue tint gives way to yellow, and finally to a pretty grey. Silver, under the same circumstances, becomes very beautifully coloured. After a long ebullition in the following solution, we obtain a yellow-brown shade, and then a remarkable fire-red :—Chlorate of potash 75 grs., carbonate of nickel 30 grs., salt of nickel 75 grs., and water 10 ounces. The following solution gives a beautiful dark brown colour :—Chlorate of potash 75 grs., salt of nickel 150 grs., and water 10 ounces. The following gives, in the first place, a red, which passes to blue, then to pale lilac, and finally to white :—Orpiment 75 grs., crystallised sal-sodae 150 grs., and water 10 ounces. The following gives a yellow-brown :—Salt of nickel 75 grs., sulphate of copper 75 grs., chlorate of potash 75 grs., and water 10 ounces. On mixing the following solutions, sulphur separates, and the brass becomes covered with iridescent crystallisations :—(1) Cream of tartar 75 grs., sulphate of copper 75 grs., and water 10 ounces. (2) Hyposulphite of soda 225 grs., and water 5 ounces. Upon leaving the brass objects immersed in the following mixture, contained in corked vessels, they at length acquire a very beautiful blue colour :—Hepar of sulphur 75 grs., ammonia 75 grs., and water 4 ounces.

A GOLDEN VARNISH FOR METAL

Take 2 ounces of gum sandarach, 1 ounce of litharge of gold, and 4 ounces of clarified linseed oil, which boil in a glazed earthenware vessel till the contents appear of a transparent yellow colour. This will make a good varnish for the final coating for enamelled and japanned goods.

PAINTING ON ZINC

Painting on zinc is facilitated by employing a mordant of 1 quart of chloride of copper, 1 of nitrate of copper, and 1 of sal-ammoniac, dissolved in 64 parts of water. To this mixture add 1 part of commercial hydrochloric acid. This is brushed over the zinc, and dries a dull grey colour in from twelve to twenty-four hours, paint adhering perfectly to the surface thus formed.

CARRIAGE VARNISH

The following is used for the wheels, springs, and carriage parts of coaches and other vehicles:—Take of pale African copal 8 lb., fuse, and add 2½ gallons of clarified linseed oil; boil until very stringy, then add ¼ lb. each of dry copperas and litharge; boil, and thin with 5½ gallons of oil of turpentine; then mix while hot with the following varnish, and immediately strain the mixture into a covered vessel. Gum animé, 8 lb.; clarified linseed oil, 2½ gallons; ¼ lb. each of dried sugar of lead and litharge; boil, and thin with 5½ gallons of turpentine; and mix it while hot as above directed. Of course these quantities will only do for big jobs, and as it has to do with metal, it has been thought advisable to include the formula in this handbook.

JAPANESE VARNISH AND ITS APPLICATION

As a fitting conclusion to these pages, a few remarks on the celebrated Japanese varnish, which is the basis and origin of all Western enamelling and japanning, may not be out of place here. The varnish is obtained from the tree known as *Rhus vernici ferv*, which is called by the Japanese *winini naki*, and grows to a height of 30 feet, and at the age of forty years has a trunk measuring 40 inches in diameter. It attains perfection at the age of fifteen years, and then produces its largest quantity of lac or varnish. This is obtained by making incisions in the bark in a horizontal direction, an operation that may be performed any time between April and October. Later in the year the lac is very thick and viscid, so that the collecting of it is attended by much greater difficulty. The lac tapper carries his own peculiar bow-shaped knife, made for the purpose, with which he cuts a short gash in the tree, and then draws the point of the knife through the cut again in order to remove any chips made by the first incision. This cut is made low down. On the opposite side of the trunk, a little farther up, he makes a second incision, and then on this side again, and so on, until he has made from six to ten cuts. After he has operated thus upon a dozen trees, the tapper returns to the first tree, and collects the fluid that has oozed from the incision, and which, at first milky white and thick, becomes, through exposure to the atmosphere, first dark brown, and finally quite black. This crude lac is known as *ki-urushi.* The tree is treated this way for from sixty to eighty days, when it dies. It is then cut down and the wood chopped up and put into hot water, which extracts the last remnant of the liquid, amounting to not more than half a pint, which forms the poorest quality of the lac. The fluid is then purified by filtering it through cotton stuff, grinding on a paint slab, and then elaborating the latter by heat. The finer sorts are bleached in shallow dishes in the sun.

The best kind is called *nashyi-urushi*, the poorer kind *hinki-urushi*, and the unbleached *jeshime-urushi*. The black varnish, *roiro-urushi*, is made from the crude lac. There are about twenty different kinds in the market, of which the above named are the most used.

The operation of varnishing is conducted in a very different manner from what it is with us. The Japanese apply their varnish mostly to woodwork; less frequently to copper and unglazed stoneware and porcelain. When applied directly to tinware the lacquer does not stick. When applied, the varnishes are generally brilliant black, dark coloured impure vermilion, impure dark green, or dark grey. Pure light colours and white cannot be produced with Japan varnish. The Japanese varnishers prepare their woodwork with the utmost care. The surfaces are smoothed and the chinks filled in with cement. The ground-coat is a mixture of the unbleached lac with paste, upon which is laid Japanese paper rubbed smooth with a brush and dried. Afterwards several very thin coats of the same varnish are applied, and each coat, after being well dried, is polished with Japanese carbon. The drying is done in a moist atmosphere, the apparatus used being a tight box whose sides are wet with water. After twenty-four hours one coat is dried, and if the article is to be black a coat of black varnish (*roiro-urushi*) is applied, but if it is to be grey or grey-brown, *jeshime-urushi* is used instead, and if it is to be red, the latter varnish is mixed with vermilion. The appearances of gold and pearl are obtained by mixing real gold dust or mother-of-pearl dust with the varnish, whereby a beautiful effect is produced. The article is then dried, rubbed down, and polished; and if there are gold, tortoise-shell, or mother-of-pearl decorations, a coat of azure varnish (*nashyi-urushi*) is applied. In applying their varnishes, the Japanese use broad brushes, the bristles of which are very stiff and inserted in wood, much in the way

that lead is in pencils. After much use the bristles get worn short, and the wood is then cut away just as in sharpening a pencil, thus exposing more of the bristles. A very fine piece of work receives no fewer than eighteen coats. These never fade with time, but rather improve, will stand a high temperature, and are totally unaffected by acids, spirits, and the like. The Japanese method is hardly likely to be introduced into Europe, because of the want of the natural material, which, when imported, becomes extremely costly, and because the process is tedious, but I have given the process here, as it may convey a wrinkle or two to workers at home.

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